

**AMENDMENTS TO THE SPECIFICATION:**

**Page 1, immediately preceding the paragraph commencing “This invention relates to sensor networks...” insert the following heading and sub-heading:**

**BACKGROUND**

**1. Technical Field**

**Page 1, 1<sup>st</sup> original paragraph:**

This invention relates to sensor networks of the kind in which data is collected from a network of mobile sensor devices, each of which is capable of taking measurements and relaying packets of data. Such devices are used by scientists taking measurements of the ~~behaviour~~ behavior of the environment. Mobile sensors are of particular application in monitoring the movement of individual objects such as vehicles or animals, and of fluid flows such as air, water, ice, lava, etc. However, they also have uses in measuring other, non-movement related, phenomena, because the mobility of the sensors avoids the researcher having to place them by hand, or the need for a fixed or uniform architecture. The properties to be measured may include temperature, pressure, or the chemical composition of the medium in which the sensors are carried. In some applications, the sensors may be attached to vehicles or other objects capable of autonomous movement. For example they may be attached to

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animals in order to monitor their migratory ~~behaviour~~ behavior or physiological condition, or to aircraft to monitor atmospheric conditions.

**Page 1, immediately preceding the paragraph commencing "The environments in which such devices..." insert the following sub-heading:**

2. Related Art

**Page 2, 1<sup>st</sup> paragraph:**

Memory and processor capacity, and energy usage, are particularly important in sensor networks. These typically consist of very small, very cheap microprocessors, ~~e.g., 16~~ e.g., 16 bit, with 32 kilobytes of RAM. They also have a finite battery supply, which would be impractical to replace given the nature of the applications in which the sensors are to be used. It is, therefore, very important that any communication protocol is energy-efficient, and also pared to a minimum in communication overhead and memory usage. The present applicant has developed a number of processes to develop an "ad hoc" wireless transmission network, in which the sensors relay data from one to another. This reduces the transmission power required overall, because two or more short-range transmissions require less power than a single transmission over the same total distance to the data collection point. (This is a consequence of the "inverse square law" of radiation propagation.) To avoid exhaustion of individual devices, these

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processes take into account the amount of traffic handled by each sensor device, and its remaining battery life, in order to determine how much relay traffic each device should be required to handle.

**Pages 4-5, bridging paragraph:**

Work by A. Cerpa, J. [[elson]] Elson, D. ~~Elstrin~~ Estrin, L. Girod, M. Hamilton and J. Zhao, refers to habitat monitoring as a driver for wireless communications technology, and focuses on power-saving by having devices switching themselves on and off according to whether they are in the vicinity of regions where interesting activity is expected, or detected by other devices. (“Habitat Monitoring: Application Driver for Wireless Communications Technology”, ACM SIGCOMM Workshop on Data Communications in Latin America and the Caribbean, Costa Rica, April 2001.) However, this process requires foreknowledge of where such activity is likely to take place.

**Page 5, immediately preceding paragraph commencing “The present invention provides...” insert the following heading:**

BRIEF SUMMARY

**Page 5, 1<sup>st</sup> full paragraph:**

The present invention ~~exemplary embodiment~~ provides a sensor device having means for periodically measuring a property, generating a measured value of the property, and storing the measured value, comprising means for determining the rate of change in the measured property and means for determining the values of the property being measured by similar devices, and means for adjusting the periodicity of measurement according to these values. Preferably the device should sense more frequently when the phenomenon of interest is changing more. This may be determined by calculating the standard deviation of a predetermined number of preceding readings. The device may sense less frequently when a sensor device's ~~neighbours~~ neighbors are taking the same readings. Sensor devices according to the invention may determine the values being measured by ~~neighbouring~~ neighboring devices by the provision on each such device of a transmitter to broadcast the measurements being taken by the device and a receiver to receive such broadcasts from similar devices.

**Page 6, immediately preceding paragraph commencing "A detailed embodiment according to..." insert the following heading:**

BRIEF DESCRIPTION OF THE DRAWINGS

**Page 6, 2<sup>nd</sup> full paragraph:**

A detailed exemplary embodiment according to the invention will now be described by way of example, with reference to the Figures, in which

**Page 6, 3<sup>rd</sup> – 5<sup>th</sup> full paragraphs:**

Figure 1 is a schematic diagram of a sensor device according to the invention;

Figure 2 is a schematic diagram of an ad hoc network made up of devices of the kind shown in Figure 1;

Figure 3 is a flow diagram illustrating the operation of the device of Figure 1; and

**Page 6, immediately preceding last full paragraph, insert the following heading:**

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

**Page 6, last full paragraph:**

Figure 1 shows a device 20 according to the invention. It comprises a wireless transmitter 21 and a wireless receiver 22, and data collection means 23 which include position sensors, and environmental or physiological sensors for determining properties of the environment of the device, or of some object to which it is attached. There is also a data buffer 24 for storing payload data (that is to say, data that is to be transmitted to

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a destination for processing) and a data store 25 for operational data (that is to say, data required for the operation of the device and in particular for controlling the transmission of the payload data). There is also computation means 26 for processing the data collected by the data collection means 23 and stored in the data buffer 24, and control means 27 for controlling the operation of the device in response to outputs from the computation means 26. The device is powered by a battery 28 whose condition is monitored and the results stored in the data store 25 with other operating parameters. (The power connections themselves are not depicted in this schematic diagram.)[[.]]

**Pages 11-12, bridging paragraph:**

In the simulation, a source of pollution is generating a gradient of pollution measurement with a circular shape. The focus of the simulation is to determine how well this circular area of pollution can be characterised characterized by data collected by the network in a finite time, with finite resources of buffer memory and battery energy. During such an experiment, a minority of the sensor devices will use up all their battery energy and become useless in terms of taking measurements and relaying data. The 'perfect' result that a network could achieve is reporting data on 100% of the area in which there is pollution. The success of the data gathering does not refer to the quantity of data packets arriving at the sinks/base-stations, but on the proportion of the area of polluted water for which data has been received. Results quoted are each

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averages of ten simulations, for which the size and position of the pollution area varies, as do the positions of the fixed sinks/base-stations, and the motions of the forty-eight mobile sensor devices. Initially two routing protocols were used, one (represented in the results ~~[[41,43]]~~ 41, 43) corresponds to the routing protocol discussed in the patent application GB0321096.0, and the other routing protocol (results ~~[[42,44]]~~ 42, 44) is a variant of it. Each routing protocol is used with a constant sensing rate (~~[[41,42]]~~ 41, 42) and a responsive sensing rate according to the invention ~~(43,44)~~ exemplary embodiment (43, 44). As explained above, the measure of success is the proportion of polluted water area that is ~~characterised~~ characterized by the end of the data-gathering experiment, which is given as a fraction on the left hand axis, with 0.95 meaning 95%. The results are tabulated below, and represented graphically in Figure 4.

**Page 13, top of page: delete "CLAIMS" and insert the following heading:**

**WHAT IS CLAIMED IS:**